I. INTRODUCTION

A. Procedural History

On June 15, 1994, Massachusetts Electric Company ("MECo" or "Company") filed its 1993 DSM Performance Measurement Report ("M&E Report" or "Report") with the Department of Public Utilities ("Department"). The Report and its accompanying appendices provide descriptions of the Company's impact and process evaluation results[1] for its 1993 demand-side management ("DSM") programs. The results of these evaluations are used by the Company and the Department for planning purposes and for determining the DSM incentive earned by the Company as a result of the implementation of its DSM programs during 1993. The DSM incentive will be recovered through the Company's 1995 Conservation Charge ("CC") rates.

On August 17, 1994, the Department opened an investigation, on its own motion, of the M&E Report. The purpose of the investigation is to examine issues including, but not limited to, the impact evaluations contained in the M&E Report which serve as a basis for evaluating and calculating the demand and energy savings that may result from the implementation of the Company's DSM programs. On December 7, 1994, the Company filed with the Department its 1995 CC filing, which incorporates the Company's proposal for stabilizing the CC rates in 1995 and 1996. These matters were docketed as D.P.U. 95-6-CC.

Pursuant to notice duly issued, public hearings on the Company's M&E Report were held

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[1] Impact evaluations use quantitative analyses to assess energy and capacity savings resulting from the implementation of DSM programs. Process evaluations focus on qualitative issues such as program design and operational efficiency. Massachusetts Electric Company, D.P.U. 90-261, at 99 (1991).

on September 26 and September 27, 1994 at the Department's offices in Boston. The Attorney General of the Commonwealth ("Attorney General") intervened as of right pursuant to G.L. c. 12, § 11E. The Conservation Law Foundation ("CLF") was granted leave to intervene.

In support of the M&E Report, the Company presented the testimony of four witnesses: Elizabeth G. Hicks, director of planning for New England Power Service Company; David I. Jacobson, principal analyst for New England Power Service Company ("NEPSCo"); Dorothy A. Conant, principal analyst for NEPSCo; and Arup Deb, associate analyst for NEPSCo. CLF filed the testimony of its witness, Jeffrey Schlegel, an independent consultant.

The evidentiary record includes 88 exhibits submitted by the Department, two exhibits submitted by CLF, and responses to 42 record requests issued by the Department.

B. Background

The impact evaluations included in the M&E Report contain estimates of DSM savings resulting from the installation of energy conservation measures ("ECMs") during 1993. The Company's determination of DSM savings estimates in a particular year are based on a four-step process. Massachusetts Electric Company, D.P.U. 92-217-B at 1-2 (1994). First, initial estimates of program savings are determined in advance of the program year, using engineering calculations of savings per ECM[2] and projections of how many measures of each type will be installed. These initial estimates are presented to the Department to project program cost-effectiveness. Id. Second, at the end of each program year, the Company updates its initial

[2] The engineering calculations of savings estimates may be informed by previous evaluations. For example, MECo's initial savings estimates for 1993 were based on its impact evaluations of programs implemented during 1992 (Tr. 2, at 32).

savings estimates to reflect the actual number of ECMs installed in that year; the Company refers to these updated estimates as "tracking estimates." Id. Third, the Company conducts a first round of post-installation measurements to provide more accurate estimates[3] of the energy and capacity savings resulting from the installation of the ECMs. MECo refers to these measurements as the First Look evaluation of savings, which are submitted in June of the year following the program year when those measures were installed. Id. Finally, pursuant to the terms of the Settlement approved by the Department in Massachusetts Electric Company, D.P.U. 92-217 (1993), the Company is required to conduct a second round of post-installation savings measurements, referred to as the Second Look evaluation of savings, for those programs that were first introduced or were "substantially redesigned" during 1993, or in which the First Look savings estimates differed from the tracking estimates by more than ten percent (See D.P.U. 92-217 Offer of Settlement at 8).[4] The Second Look savings estimates replace the First Look estimates since they are based on more complete data that are sometimes collected through a full year of post-installation measurements. The Second Look evaluations are submitted to the Department one year after the First Look evaluations. D.P.U. 92-217-B at 1-2.

The M&E Report contains the First Look savings estimates for ECMs installed in 1993.

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[3] The Department has recognized that kilowatts and kilowatthours saved by DSM programs are not as easily measured as kilowatts and kilowatthours generated or consumed. Massachusetts Electric Company, D.P.U. 90-261, at 100 (1991). Because DSM savings cannot be measured exactly, savings measurement results are referred to as savings estimates.

[4] Programs for which Second Look savings estimates are required are the Design 2000, Performance Engineering and Verification Service, Small Commercial and Industrial, Appliance Recycling, Residential Complementary, and Multifamily Retrofit Programs (Exh. DPU-1, I-66, 67). These programs are discussed in Section IV, below.

Based on these savings estimates, MECo has proposed recovery of a 1993 after-tax incentive of $1,980,799 (Exh. DPU-1, App. I-3).[5] Table 1 summarizes the results of the impact evaluations contained in the M&E Report.

In this Order, the Department addresses whether the impact evaluations included in the M&E Report satisfy the criteria established by the Department for the review of such evaluations.[6] In addition, the Department addresses whether the Company's proposed 1995 CC rates are appropriate and are supported by the record in this proceeding. Because the Company's incentive payment associated with the implementation of DSM programs during 1993 is based on the savings estimates included in the M&E Report, the Company may be required to recalculate the incentives, and, therefore, the CC rates, to reflect findings and directives in this Order.

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5 The after-tax incentive amount is based on a formula approved by the Department in D.P.U. 92-217. See D.P.U. 92-217 Offer of Settlement, Att. 1, App. A. Pursuant to D.P.U. 92-217, the Company shall recover the 1993 incentive through its CC rates. See D.P.U. 91-217 Offer of Settlement, Att. 1, at 7-8.

6 The Department does not address in this Order the process evaluations included in the M&E Report. The Department notes that electric companies are expected to consider all recommendations contained in the process evaluations and to revise program designs to reflect those recommendations that the companies consider to be appropriate.

TABLE 1. SUMMARY OF 1993 DSM ACTIVITIES

Total DSM Expenditures	$ 47.1 million
Energy Savings, Annual	112 GWH
Percent of Company Sales	0.7%
Peak Demand Savings, Annual	33 MW
Percent of Peak Demand	1.2%
Energy Savings, Lifetime	1,640 GWH

Note: "GWH" stands for gigawatthour, which equals 1 million kilowatthours ("KWH"). "MW" stands for megawatt, which equals 1,000 kilowatts ("KW").

(Exh. DPU-1, at I-11).

II. STANDARD OF REVIEW

In D.P.U. 92-217-B, the Department introduced a new standard of review for future impact evaluations.[7] Id. at 6. The Department stated that, in order for a company's DSM savings estimates to be accepted, the company must demonstrate that its impact evaluations are reviewable, appropriate, and reliable.[8] Id.

An impact evaluation filing is considered reviewable if it is complete, clearly presented,

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[7] The Department notes that the standard of review discussed here applies specifically to the review of the Company's DSM savings estimates. The ratemaking treatment to be afforded revenues that are calculated based on these savings estimates (i.e., the Company's DSM incentive) is addressed in Section V of this Order.

[8] In D.P.U. 92-217-B, the Department stated that this standard of review "reflects the criteria that have been established for the review of electric companies' demand forecasts. This is appropriate because, similar to electric demand forecasts, DSM impact evaluations employ input data and complex methodological techniques to develop assessments that are important to the utilities' resource planning processes and to ratepayer costs." Id. at 6.

and contains a summary that sufficiently explains all assumptions and data presented. Id. An impact evaluation is considered appropriate if evaluation techniques selected are reasonable given consideration of the characteristics of a particular DSM program, the company's resources, and the available methods for determining demand and energy savings estimates.[9] Id. at 6-7. Finally, an impact evaluation is considered reliable if the savings estimates included in the evaluation are sufficiently unbiased and are measured to a sufficient level of precision, again, given consideration of the characteristics of a particular DSM program, the company's resources and the available methods for determining demand and energy savings estimates. Id. at 7.

The Department previously has found substantial bias in engineering estimates of DSM savings and, accordingly, generally has required companies to measure savings after the installation of ECMs. Boston Edison Company, D.P.U. 90-335, at 106 (1992) ("BECo"); Nantucket Electric Company, D.P.U. 91-106/138, at 212-215 (1991); Massachusetts Electric Company, D.P.U. 90-261, at 79, 80, 85 (1991); Western Massachusetts Electric Company, D.P.U. 91-44, at 142-143 (1991) ("WMECo"). The Department has identified additional sources of bias in savings estimates, including: (1) poor selection of samples used in savings measurement analyses, WMECo at 138; (2) inaccurate hours-of-use estimates, BECo at 105; WMECo at 142; D.P.U. 90-261, at 109-110; (3) the failure to account for free riders, BECo at 111-112; (4) the failure to account for interactions of multiple DSM measure installations, Cambridge Electric Light Company/ Commonwealth Electric Company, D.P.U. 89-242/246/247, at 78-79 (1990);

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[9] The Department recognizes that the state-of-the-art in methods used to determine DSM savings estimates is evolving and expects companies to remain up to date with technological and methodological advances in this field.

and (5) overestimated persistence of savings. BECo at 110-111; WMECo at 147-148.

With respect to the precision of savings estimates, the Department recognizes that, in certain instances, the costs of obtaining more precise estimates of savings may exceed the incremental value of those more precise estimates. See D.P.U. 90-261, at 100. Therefore, the Department directs companies to pursue savings measurement activities that maximize the level of precision of the DSM savings estimates, but only to the extent that the marginal value of the more precise savings estimates exceeds the marginal cost of obtaining the additional precision. See BECo at 100-103, 110; D.P.U. 90-261, at 106, 108.

III. DSM SAVINGS ESTIMATION TECHNIQUES

The Department has not specified the savings estimation techniques to be used by companies in their impacts evaluations. Instead, companies are allowed the flexibility to select techniques that they deem most appropriate, provided that the techniques satisfy the standards of review set forth in Section II, above. The M&E Report that is the subject of this Order incorporated a variety of savings estimation techniques, including engineering estimates, billing analysis, end-use metering, load shape data, and surveys.[10]

As a general rule, the first step in developing energy and demand savings estimates consists of producing engineering estimates of annual savings, based on the number of ECMs installed. As stated in Section II, above, the Department generally has required companies to measure actual savings after the installation of the ECMs. Post-installation measurement

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[10] For a full description of these techniques, see Cambridge Electric Light Company/Commonwealth Electric Company, D.P.U. 94-2/3-CC at 9-18 (1994); D.P.U. 92-217-B at 7-16.

techniques typically measure the savings for a sample of program participants in a particular year (the "participant group"). The savings estimates for the participant group then are extrapolated to the entire population of program participants. One frequently-used extrapolation method involves the calculation of a "realization rate" for the participant group. The realization rate is defined as the ratio of the measured savings estimates for the participant group to the engineering savings estimates for the same group. To calculate total program savings estimates, the engineering savings estimates for the entire population of program participants are multiplied by the realization rate.

As stated in Section I, above, the savings estimates produced by DSM impact evaluations are used by the Company and the Department for planning purposes and for determining the DSM incentive to be collected by the Company in a particular year. In order to serve these purposes, and to satisfy the Department's standard of review, the savings estimates must (1) reflect the period of time over which the ECMs can be expected to generate savings (i.e., "lifetime" savings estimates),[11] (2) reflect the level of demand savings that occurs at the time of, or coincident with, a company's peak power demand (i.e., "coincident" demand savings),[12] and (3) be exclusive of the level of savings that would have occurred in the absence of implementation of the DSM programs

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[11] Lifetime savings estimates typically are calculated as the product of (1) annual savings estimates, (2) projected measure lives, and (3) savings persistence adjustment factors.

[12] Savings estimates that do not take into account the level of demand savings that occur at the time of a company's peak power demand are referred to as "non-coincident" demand savings estimates.

(i.e., "net" savings estimates).[13]

IV. THE COMPANY'S DSM IMPACT EVALUATIONS

A. Introduction

The Company submitted impact evaluations for all of the DSM programs implemented during 1993. Programs targeting the commercial/industrial ("C/I") sector include the Energy Initiative, Design 2000, Small Commercial and Industrial, and Performance Engineering and Verification Service Programs (Exh. DPU-1, at I-11 through I-17). Programs targeting the residential sector include the Electric Space Heat, Multi-Family, Residential Lighting, Energy Fitness, Appliance Recycling, Energy Crafted Home, Water Heater Rebate, Home Energy Management, and Complementary RFP Programs (id.). Table 2 attached to this Order provides a comparison of the 1993 savings estimates for each program with the savings estimates determined from the Company's engineering calculations and the number of ECMs installed (i.e., the tracking estimates).

B. Reviewability

As stated in Section II, above, a company's impact evaluation filing is considered reviewable if it is complete, clearly presented, and contains a summary that sufficiently explains all assumptions and data presented. Based on a review of MECo's M&E Report, the Department finds that the filing satisfies the criteria for reviewability. The Department

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[13] Savings estimates that do not take into account the level of savings that would have occurred in the absence of implementation of the DSM programs are referred to as "gross" savings estimates. To determine net savings estimates, gross savings estimates must be adjusted for non-program factors that may affect the electricity consumption of program participants, such as free-ridership, economic conditions, weather, spillover, and snap-back.

particularly commends the Company for the series of tables summarizing its savings estimates, contained in Appendix I-1 of the Report.

C. The Commercial/Industrial Sector

1. Energy Initiative and Design 2000 Programs

a. Introduction

The Energy Initiative ("EI") Program promotes the installation of energy-efficient retrofit measures and efficient energy management practices in existing commercial, industrial and governmental structures (Exh. DPU-1, at I-34). The program offers financial rebates for the installation of ECMs as well as technical information and assistance, plus commissioning services for large, complex projects (id.). The Company stated that 485 customers participated in the EI Program during 1993 and reported annual energy savings of 32,615 MWH and annual demand savings of 8,188 KW (id. at I-35).

The Design 2000 ("D2000") Program targets time-dependent opportunities for the installation of energy-efficient equipment in the new construction, renovation, remodeling, and failed-equipment replacement markets (Exh. DPU-1, at I-24). The program offers financial rebates for the installation of ECMs as well as technical information and assistance, plus commissioning services for large, complex projects (id.). The Company stated that 375 customers participated in the D2000 Program during 1993 and reported annual energy savings estimates of 28,972 MWH and annual demand savings of 6,035 KW (id. at I-25).

End-uses addressed through both programs include energy-efficient lighting, variable speed drives, premium efficiency motors, custom and process equipment, refrigeration, building

shells, and heating, ventilation, and air conditioning ("HVAC") systems and controls (Exh. DPU-1, at I-24, I-34). Table 3 attached to this Order summarizes the energy savings reported by the Company for each end-use. The Company stated that, since the end uses addressed by the EI and D2000 Programs are similar, it applied the results of the impact evaluation studies for these end uses to both programs. Therefore, the Department jointly reviews the impact evaluations for the EI and D2000 Programs. With the exception of lighting measures, the Department's review does not distinguish between ECMs installed in the EI Program and ECMs installed in the D2000 Program.

b. Lighting Measures

i. EI Program

(A) Description

The Company reported annual energy and demand savings estimates of 21,208 MWH and 5,611 KW, respectively, for lighting ECMs installed through the EI Program during 1993 (Exh. DPU-1, at I-39). The Company developed the energy savings estimates by using a billing analysis that involved a regression analysis of electric bills from samples of program participants and non-participants (id. at I-36). In the regression analysis, the 1993 energy consumption of the participants and non-participants was predicted as a function of six independent variables (id. at III-8). One of the independent variables was the engineering savings estimates for lighting measures installed during 1992 (the value of this variable was zero for non-participants) (id.).[14]

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[14] The Company stated that the coefficient on the engineering estimate variable represented the realization rate for savings resulting from the installation of lighting measures (Exh. DPU-1, at III-6).

The other independent variables were selected to account for various factors unrelated to the program that might have affected energy consumption for the participants and non-participants during the post-installation period (id.).[15]

The Company applied its regression equation to billing data for 137 customers who participated in the program during 1992 (the "participant group") and 298 non-participants (the "comparison group") (id. at III-5).[16] The Company reported that the customers included in the participation and comparison groups were similar to the population of 1993 EI participants and non-participants, according to building type and energy consumption level (id., App. III-1, at 4-7 through 4-16).

The Company showed that the regression equation produced coefficients of the independent variables that accurately predicted the 1993 energy consumption for the members of the participant and comparison groups (id. at III-8).[17] Based on the results of the regression analysis, the Company reported a net realization rate of 77 percent (id.).[18] In parallel to its billing

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[15] The other five independent variables reflected, for each customer included in the analysis, (1) 1991 (i.e., pre-installation) energy consumption, (2) a decrease in lighted space, (3) removal of electrical equipment, (4) an increase in total number of employees, and (5) an increase in the amount of heated space (Exh. DPU-1, at III-8).

[16] The Company required that customers included in both groups have (1) no changes in tenancy, (2) engineering estimates of energy savings less than consumption, (3) completed surveys providing the information used in the independent variables of the regression equation, and (4) exhibited no large change in energy consumption not verified by survey data (Exh. DPU-1, App. III-1, at 4-2 through 4-6).

[17] All of the independent variables in the Company's analysis were statistically significant (Exh. DPU-1, at IV-15). The Company's analysis explained 99 percent of the variation in the level of energy consumption and 52 percent of the variation in the change in energy consumption (id.; Exh. DPU-11).

analysis, the Company used end-use metering to estimate a 75 percent gross energy savings realization rate (id., App. IV-2, at 2).

The Company tested the sensitivity of the results of the regression model to different sets of variables by constructing four regression equations in which the independent variables were changed (Exh. DPU-1-6; RR-DPU-1). The realization rates produced by these equations were 77 and 79 percent, and the equations had statistical properties (e.g., t-ratios) comparable to the equation used by the Company (id.).

The Company also tested the sensitivity of the results of the regression model to different subsamples of data observations by examining eleven different sets of participant and comparison group members (Exhs. DPU-1, App. III-1, at A-2; DPU-8; DPU-9; DPU-10; DPU-54). The realization rates that resulted from ten of these subsamples ranged from 48 percent to 121 percent (id.). The Company stated that this process tested the effect on the results of the regression analysis of those data observations with large residuals or those observations having a particularly strong influence on the results of the analysis (Exh. DPU-1, App. III-1, at A-1). The Company stated that, because there are no generally accepted criteria which provide a firm basis for excluding any of these data observations from the analysis, it used the full sample of data observations (id., App. III-1, at A-3).

To determine net lifetime energy savings, the Company multiplied the engineering estimates of annual lighting energy savings for the entire population of 1993 participants by

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[18] The Company stated that the precision level of the realization rate was ±54 percent at the 90 percent confidence level; i.e., there was a 90 percent probability that the actual realization rate was within 54 percent of 77 percent, i.e., between 35 and 119 percent (Exh. DPU-1, at III-7).

(1) the realization rate of 77 percent, and (2) measure-specific projected lifetimes (id. at I-39).

To determine gross demand savings estimates for lighting measures installed through the EI Program, the Company conducted end-use metering at the facilities of 44 program participants which were chosen to be representative of all participants (id. at I-39). The end-use metering resulted in gross, non-coincident demand savings estimates that were 95 percent of the engineering estimates of lighting demand savings at those facilities (id., App. IV-2, at 2). The end-use metering also produced lighting coincident demand factors of 85 percent and 75 percent for the summer and winter periods, respectively (id.).[19]

The Company determined the gross coincident demand savings for lighting by multiplying its engineering estimates of demand savings by (1) the 95 percent gross realization rate, (2) the coincident demand adjustment factors, and (3) a persistence factor of 94 percent, based on a survey of 192 sites of 1993 EI Program participants that assessed the number of EI lighting installations that were still in place and functioning (id. and at App. IV-7). Finally, net lifetime demand savings estimates were calculated as the product of (1) the gross savings estimates, (2) measure-specific free-rider adjustment factors (averaging 3 to 4 percent), as developed through the process evaluation for the program, and (3) measure-specific projected lifetimes (id. at I-39 and App. I-1-13).

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[19] The Company reported the following precision for the savings estimates at the 90 percent confidence level: ±5.3 percent for the non-coincident demand savings; ±8.2 percent for the coincident summer demand savings; and ±14.0 percent for the coincident winter demand savings (Exh. DPU-1, App. IV-2, at 2).

(B) Analysis and Findings

The record demonstrates that the Company used a regression analysis of the electric bills of selected program participants and non-participants to determine energy savings estimates for lighting measures installed in the EI Program. The record further demonstrates that (1) the regression equation explained most of the variation in energy consumption and changes in energy consumption for the participant and comparison group members, (2) the energy savings realization rate was stable as the dependent variable and the sets of independent variables (which account for non-program factors that affect electricity consumption) in the regression equation varied, (3) the energy savings realization rate resulting from the regression analysis was consistent with that derived from end-use metering, and (4) the energy savings estimates were adjusted to account for persistence of energy savings and free riders. The Department accepts the set of data observations used for the analysis (i.e., participant and comparison group members) and finds that the energy savings estimates produced by the regression analysis were sufficiently unbiased and were measured to a sufficient level of precision.

The record demonstrates that the Company determined the demand savings estimates for lighting measures installed in the EI Program based on the results of end-use metering, adjusted for savings persistence and free-ridership factors. The Department finds that the Company, through (1) the selection of metering samples that were statistically representative of the total population of program participants, (2) on-site inspections of lighting measures to determine savings persistence, and (3) surveys of program participants to determine free ridership, has demonstrated that its demand savings estimates are sufficiently unbiased. In addition, the

Department finds that the demand savings estimates were measured to a sufficient level of precision.

Based on the above analysis, the Department finds that the 1993 impact evaluation for lighting measures installed in the EI Program satisfies the criteria established by the Department for the review of impact evaluations and, accordingly, accepts the savings estimates for lighting measures installed during 1993. In future impact evaluations, the Company is directed to continue its assessment of lighting savings persistence to include the effect of any deterioration in the performance of the installed lighting measures. See D.P.U. 90-261, at 110.

ii. Design 2000 Program

(A) Description

The Company reported annual demand and energy savings estimates of 2,010 KW and 10,897 MWH, respectively, for lighting ECMs installed through the D2000 Program during 1993 (Exh. DPU-1, at App. I-1-5). The impact evaluation for D2000 lighting consisted primarily of a time-of-use metering study, in which lighting loggers were installed at 52 representative sites for two-week periods (id. at I-27). Based on the results of the study, the Company developed coincident demand factors of 80 percent and 77 percent, for the summer and winter periods, respectively, and an average annual hours-of-use figure of 4,445 hours (id., App. IV-3, at 1; Exh. DPU-15).[20]

The Company calculated gross non-coincident demand savings estimates as the product of

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[20] The precision (at the 90 percent confidence level) for the average annual hours of use for all D2000 lighting measures was ±7.1 percent (Exh. DPU-15). The corresponding precisions for summer and winter diversity factors were both ±5.3 percent (Exh. DPU-1, App. IV-3, at 1).

(1) engineering estimates of the non-coincident savings, (2) the number of lighting measures installed, and (3) a savings persistence factor of 94 percent that was developed through the EI lighting persistence study (Exh. DPU-1, at I-27). Gross coincident demand savings estimates were calculated by multiplying the non-coincident savings estimates by the coincident demand factors produced by the time-of-use metering study (id.). To determine gross energy savings estimates, the Company multiplied the gross non-coincident demand savings estimates by the average annual hours-of-use figure produced by the metering study (id.).

Finally, net lifetime demand and energy savings estimates were calculated as the product of (1) the gross savings estimates, (2) measure-specific free-ridership factors that were developed through the D2000 process evaluation, and (3) measure-specific projected lifetimes (id. at I-27 and App. I-1-12).

(B) Analysis and Findings

The record demonstrates that the Company used measurements to determine hours of use, coincidence factors, and a persistence factor, and appropriately accounted for free riders by using the results of its process evaluation. The Department recognizes that, although the Company did not measure the demand load of the lighting measures installed through this program, it has improved on its previous evaluation by using measurements for most of the components of its savings estimates, emphasizing those components for which the greatest degree of uncertainty exists. Therefore, the Department finds that the Company's energy and demand savings estimates for lighting measures installed through the D2000 Program during 1993 are sufficiently unbiased and are measured to a sufficient level of precision. Accordingly, the Department accepts the

Company's savings estimates.

However, the Department finds that, although the demand load of lighting measures previously has been characterized as relatively constant and relatively well-known (see D.P.U. 92-217-B at 27), measurements of power consumption of baseline equipment and equipment installed through the program should improve the reliability of the resulting savings estimates. Accordingly, the Department directs the Company to measure power consumption at an appropriate sample of lighting installations in its next impact evaluation of D2000 lighting.

c. Variable Speed Drives

i. Description

The Company installed variable speed drives ("VSDs") on motors[21] that represent 9,110 horsepower ("HP") through the 1993 D2000 Program with annual energy savings estimates of 7,298 MWH and annual winter demand savings estimates of 1,139 KW (Exh. DPU-1, at App. I-1-16). The Company installed VSDs on motors that represent 478 HP through the 1993 EI Program with annual energy savings estimates of 183 MWH and annual winter demand savings estimates of 47 KW (id. at App. I-1-17).

The Company stated that gross energy and coincident demand savings estimates for each VSD installation were developed using one of four distinct methods: (1) pre- and post-installation metering; (2) the extrapolation of results from metered VSDs to non-metered VSDs installed at the same site; (3) engineering models using installation-specific system

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[21] A variable speed drive is a device that, when installed on a motor, regulates the power input to the motor in accordance with the output load placed on the motor (Tr. 2, at 54-56). The result of installing a VSD on a motor is that the motor (1) requires less power to meet its load requirements, and (2) operates at a higher level of efficiency (id.).

characteristics and operating parameters;[22] and (4) unit-savings estimates (i.e., KWH and KW saved per-installed-VSD-horsepower) derived from one or more of the three methods listed above (id. at IV-40 through IV-41).[23] The Company stated that the method used for a given installation depended on the availability of data, and the nature and prevalence of the application (id. at IV-41).

The Company stated that net annual savings estimates were determined by adjusting the gross savings estimates by (1) a persistence factor of 97 percent, as determined through the Company's non-lighting persistence study (id. at IV-23 through IV-24), and (2) a free-ridership factor of 11 percent that was developed through the Company's D2000 process evaluation (id. at I-32).[24] Finally, net lifetime savings estimates were determined by multiplying the net annual estimates by a measure life of 15 years (id.).

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22 The Company stated that installation-specific system and operating data were collected through telephone interviews. In addition, the Company noted that the development of a maximum motor load factor, which is a key parameter used in the engineering models, was one of the objectives of its 1993 Motor Performance Study (Exh. DPU-1, at IV-45 through IV-50)

23 Savings estimates from approximately 22 percent of the VSD installations, in terms of installed HP, were developed using the first and second methods. Savings from approximately 51 percent of the VSD installations were developed using the third method. Finally, the remaining 28 percent of the VSD installations were developed using the fourth method (RR-DPU-28).

24 The Company stated that the D2000 free-ridership adjustment factor was applied to VSDs installed through the EI Program because not enough VSD installations were included in the EI process evaluation to obtain a valid free-ridership estimate (Exh. DPU-1, at I-40).

ii. Analysis and Findings

A comparison of the 1993 VSD impact evaluation to the 1992 VSD evaluation demonstrates that, for both years, the Company used the same four methods to determine savings estimates resulting from the installation of VSDs. See D.P.U. 92-217-B at 30-31. In D.P.U. 92-217-B, the Department accepted the savings estimates produced by the first two savings estimation methods listed above (i.e., metering and extrapolation of metered data). Id. at 35-36. However, the Department directed the Company to assess savings persistence in future impact evaluations of VSDs. Id. at 38. The record in the instant proceeding shows that the Company adjusted 1993 VSD savings estimates to account for persistence. Therefore, the Department finds that the savings estimates produced by the first and second methods are sufficiently unbiased and are measured to a sufficient level of precision.

The Department, in D.P.U. 92-217-B, did not accept the savings estimates produced by the latter two savings estimation methods listed above because of the miscalculation and misapplication of the maximum motor loading factor that is included in the engineering models. Id. at 36-38. The Department also stated that the Company should take appropriate steps to ensure that the key data inputs to the engineering models are based on on-site measurements. Id. In the instant proceeding, the Department finds that, in the 1993 impact evaluation, the Company (1) correctly calculated and applied the motor loading factor, and (2) took appropriate steps to improve the quality of the models' input data. Therefore, the Department finds that the savings estimates produced by these methods are sufficiently unbiased and are measured to a sufficient level of precision.

Based on the above analysis, the Department finds that the 1993 impact evaluation for VSDs installed through the EI and D2000 Programs satisfies the criteria established by the Department for the review of such evaluations. Accordingly, the Department accepts the savings estimates reported by the Company for 1993.

d. Other Motors

i. Description

The Company installed 442 energy-efficient motors through the D2000 Program during 1993 with annual energy and coincident demand savings estimates of 460 MWH and 78 KW, respectively (Exh. DPU-1, at I-28, I-29; App. I-1-14). The Company installed 2,162 energy-efficient motors through the EI Program during 1993 with annual energy and coincident demand savings estimates of 2,912 MWH and 492 KW, respectively (id., App. I-1-15).

The impact evaluation for motors installed through the D2000 and EI Programs consisted primarily of three components: (1) surveys on the operating characteristics of 600 motors; (2) hours-of-use metering of 93 motors; and (3) power metering of 80 motors at 14 sites (id. at I-30, IV-15; Tr. 1, at 109).

The Company determined gross annual demand savings estimates in the following manner. First, gross non-coincident demand savings per energy-efficient motor installed were determined based on the measured performance factors[25] and the differences between the efficiencies of the motors installed through the program and the replaced motors (Exh. DPU-1, at IV-18).[26]

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[25] The performance factor is a normalized factor which adjusts for the loading factor and the part-load efficiency of a motor (Exh. DPU-1, at IV-15).

Coincident demand savings estimates were calculated by multiplying the non-coincident savings estimates by coincident demand factors developed through the Company's hours-of-use metering activities (id. at IV-15). Gross annual energy savings estimates were calculated by multiplying the non-coincident demand savings estimates by annual hours-of-use estimates developed through the Company's hours-of-use metering activities (id. at IV-18).

Net lifetime energy and coincident demand savings estimates were determined through a three-step process. First, the annual savings estimates were multiplied by an average motor persistence factor of 92 percent that was developed through visits to 21 sites representing 638 motors (id. at IV-17). Second, the savings estimates were multiplied by free-ridership factors of eleven percent for the D2000 Program and four percent for the EI Program, as determined through a limited-scale process evaluation of the two programs (id., App. I-1, at 14-15). Finally, net lifetime savings estimates were determined by multiplying the net annual savings estimates by a measure life of 20 years (id.)

ii. Analysis and Findings

The record indicates that, for motors installed through the D2000 and EI Programs, the Company determined energy and demand savings estimates primarily through after-the-fact metering of power load and hours-of-use. Consistent with Department precedent, the Department finds that end-use metering is an appropriate technique for determining savings estimates for this program. See D.P.U. 92-217-B at 42.

The record further indicates that the Company stratified its metering sample in an effort to

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[26] Efficiencies for replaced motors in new construction and failed motor installations were based on the Company's 1992 Motor Baseline Study (Exh. DPU-1, at I-30).

ensure that the motors included in the sample would be representative of the total population of motors installed during 1993. In addition, the Company accounted for the effects of savings persistence and free-ridership in determining net savings estimates. For these reasons, the Department finds that the savings estimates are sufficiently unbiased and are measured to a sufficient level of precision.

Based on the above analysis, the Department finds that the 1993 impact evaluation for motors installed through the D2000 and EI Programs satisfies the criteria established by the Department for the review of such evaluations. Accordingly, the Department accepts the 1993 motor savings estimates as reported.

e. Custom, HVAC, Building Shell, and Refrigeration Measures

i. Description

The Company reported that a wide variety of custom, HVAC, building shell, and refrigeration ECMs were installed through the D2000 and EI Programs during 1993 (Exh. DPU-1, at App. I-1-6, -7, -10, and -11).[27] In all, the Company claimed annual energy and demand savings of 18,199 MWH and 3,477 KW, respectively, resulting from these installations (id. at App. I-1-5).[28]

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[27] Installations addressed under "custom measures" required installation-specific (i.e., custom) operational data to calculate savings estimates and rebate levels. Thus, these installations were not included in the "prescriptive" components (e.g., lighting or HVAC measures) of the EI and D2000 Programs.

[28] Projects/technologies that accounted for most of the reported savings included energy management ("EM") systems (29 percent), the redesign of two HVAC systems (23 percent), and a variety of refrigeration and cooling projects (34 percent) (Exh. DPU-1, App. IV-9, at 2 and 9; App. IV-10, at 2; App. IV-8, § 3, at 6; and App. IV-4, at 8).

Gross savings estimates for the majority of these installations were based on engineering analyses that used as input data site-specific operational information obtained through site visits and telephone interviews (id. at I-31, I-33, and I-40).[29] The Company stated that it incorporated metered data, measurements of key parameters, and bill comparisons into the engineering analyses for many of these installations (id., App. IV-9, at 10-14; App. IV-10, at 4, 9, and 18; App. IV-4, at 2-7). The Company stated that it attempted to assess the validity of the results from many of its site-specific engineering analyses by using a billing analysis based on a partial year of data (Exh. DPU-59).[30] For those installations where site-specific information could not be obtained, gross savings estimates were determined using either (1) realization rates that were produced by the engineering analyses discussed above or (2) savings impact parameters developed through the impact evaluations for the 1992 program year (id.).[31]

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[29] The type of operational information used varied with the type of equipment and its use, but generally included (1) the amount and size of equipment, (2) hours of use, (3) coincidence factors, (4) re-calculations (subsequent to those included in the original project application) of the equipment's efficiency at the operating conditions observed or expected, (5) interactions with other equipment, and/or (6) whether the equipment actually operated under various conditions (Exh. DPU-1, App. IV-4, at 2-9; App. IV-8, § 1, at 8-10, § 2 at 7, § 3 at 7; App. IV-9, at 8-20; App. IV-10, at 7, 13-21).

[30] However, the Company reported realization rates of +426 percent and -514 percent for the two largest projects, which together comprise 29 percent of expected savings (Exh. DPU-59). The Company noted that, for each of these projects, the projected savings from the ECMs represented less than 5 percent of total consumption (id.).

[31] The Company reported energy realization rates of 68 percent for one large group of custom ECMs, 88 percent for another large group of custom and HVAC ECMs, 81 percent for a small group of HVAC measures, and 95 percent for most of its EM systems, along with related capacity realization rates (Exh. DPU-1, App. IV-9, at 4-7; App. IV-10, at 2). The Company reported a 53 percent demand realization rate for its thermal storage systems (id., App. IV-4, at 8).

Net annual savings estimates were developed by adjusting the gross savings estimates by factors that accounted for (1) free riders, based on the results of the EI and D2000 process evaluations[32] and (2) savings persistence, based on the Company's non-lighting persistence studies (Exh. DPU-1, at I-33, I-40, and I-41).[33] Finally, net lifetime savings estimates were calculated as the product of the annual savings estimates and measure-specific lifetimes (id. at App. I-1-6 through App. I-1-7).

ii. Analysis and Findings

The record shows that savings estimates for most ECMs were based on the results of on-site surveys and re-calculated engineering estimates. The record also shows that the Company used metered data and measurements of key parameters, as well as bill comparisons, in developing many of its re-calculated engineering estimates. Finally, the record shows that the Company adjusted the gross savings estimates to account for free riders and savings persistence.

The Department finds that the Company performed its engineering analysis thoroughly and appropriately used measurements to support many of its calculations. In addition, the Department notes that the realization rates reported for these end uses are consistent with those reported for other end uses installed through the EI and D2000 Programs, and for other C/I programs.[34]

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[32] A wide variety of free-ridership rates were used, depending on the type of project, ranging from 0 percent to 38 percent, and averaging 22 percent (Exh. DPU-1, at I-1-6, I-1-7, I-1-10, and I-1-11).

[33] The Company reported overall persistence factors of 97 percent for custom VSDs, 105 percent for custom HVAC and process cooling equipment, 94 percent for EM systems, and 59 percent for liquid pressure amplifiers in refrigeration systems, with related persistence factors for capacity savings (Exh. DPU-1, App. IV-8, § 1, at 10; § 2, at 6; § 3, at 7; and § 4, at 5).

(continued...)

Based on our review of the impact evaluations for these end uses, the Department finds that the savings estimates are sufficiently unbiased and are measured to a sufficient level of precision. Accordingly, the Department accepts the Company's estimates of savings for custom, HVAC, building shell, and refrigeration ECMs in the D2000 and EI Programs.

f. Other End-Uses

The Department notes that the combined lifetime energy savings estimates for food and process measures installed through the 1993 D2000 and EI Programs represent less than one percent of the total lifetime savings estimates for these program. For this reason, the Department addresses these end-uses in a combined manner. Based on its review of the impact evaluations associated with these end-uses, the Department finds that the evaluations are appropriate and that the savings estimates included in the evaluations are sufficiently unbiased and are measured to a sufficient level of precision. Accordingly, the Department accepts the 1993 savings estimates for these end-uses as submitted by the Company.

2. Small Commercial and Industrial Program

a. Description

The Small Commercial and Industrial ("Small C/I") Program is a retrofit program that provides direct installation of lighting and non-lighting ECMs[35] to nonresidential customers with

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[34](...continued)
The Department notes that the realization rates produced by the billing analysis of two large projects (i.e., +426 percent and -514 percent) illustrates the difficulty of using such an analysis to estimate savings for projects where the projected savings are a small fraction of total consumption.

average monthly demand of less than 50 KW or annual energy consumption of less than 150,000 KWH (Exh. DPU-1, at I-44). In 1993, the program served 2,454 customers (id.). The Company reported annual energy and demand savings estimates of 15,510 MWH and 5,613 KW, respectively, from installations in 1993 (id.; RR-DPU-7).

The Company determined energy savings estimates for lighting measures based on the combined results of a billing analysis and an end-use metering study (Exh. DPU-1, at I-45). The billing analysis was based on a regression equation which calculated post-installation energy consumption as a function of (1) pre-installation energy consumption,[36] and (2) engineering estimates of energy savings resulting from the installation of lighting measures (id. at III-10, III-11). The study sample consisted of 1,096 customers who participated in the program during 1992 ("participant group") and 1,569 nonparticipants who were eligible to but did not participate ("comparison group") (id.). Both participant and comparison groups were stratified by facility type (based on SIC code) and annual energy consumption in 1991 (id., App. III-2, at 9, 16). The model produced a net energy savings realization rate of 44 percent,[37] plus or minus eleven percent at the 90 percent confidence level (id. at III-11).

The end-use metering study included 21 installations from 1991, 19 installations from

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35 Savings for 1993 Small C/I Program installations are attributable primarily to lighting measures, which represent 87 percent of program energy savings and 95 percent of program demand savings (Exh. DPU-1, at App. I-1-19).

36 The pre-installation and post-installation periods were calendar years 1991 and 1993, respectively (Exh. DPU-1, App. III-2, at 5).

37 The Company stated that, because the billing analysis included a comparison group, the analysis implicitly accounted for free-ridership and, thus, produced net savings estimates (Exh. DPU-1, at III-10).

1992, and one installation from the 1993 program (id. at IV-4). The Company stated that, except for the inclusion of the 1993 installation, the study essentially was unchanged from the study performed for the 1992 program year.[38] The Company added that the results of the 1992 study were revised to reflect the mix of ECMS installed during 1993 (id., at IV-5). The metering study developed gross energy savings estimates using measured non-coincident demand savings and hours-of-use data (id.). To determine the metering study's net savings estimates, the Company adjusted the gross savings estimates to account for persistence[39] and free-ridership (id. at IV-45 through IV-46).[40]

The Company stated that, because the confidence intervals of the billing analysis and the end-use metering study do not overlap (i.e., the high end of the 90 percent confidence interval for the billing analysis is less than the low end of the 90 percent confidence interval for the end-use metering), it is highly likely that the results of at least one of the analyses are incorrect (id., App. III-3, at 2). The Company stated, however, that it has not been able to identify a sufficiently significant flaw to either study which could explain the different results (id.). Therefore, the

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38 The Company stated that it was appropriate to use information from the 1992 study for two reasons. First, the Company stated that there were no significant changes to the program between 1992 and 1993 and, therefore, the realization rates for the two program years should remain constant (Tr. 1, at 44). Second, the Company stated that an end-use metering study would cost an average of $10,000 per site and that this cost precluded the Company from including more sites (id. at 45).

39 The Company reported a persistence factor of 91 percent based on data from the 1993 Measure Persistence Study (Exh. DPU-1, at I-45).

40 The Company developed measure-specific free-ridership factors based upon a study completed as part its 1992 DSM Performance Measurement Report (Exh. DPU-1, at I-46, IV-7).

Company stated that it chose to apply equal weight to each analysis and calculate the numerical average (id.). Based on this decision, the Company estimated a net energy savings realization rate of 58 percent, plus or minus 31 percent at the 90 percent confidence level (id., App. I-2, at 10; RR-DPU-7). The Company calculated net annual energy savings by multiplying the engineering estimates of lighting energy savings for the entire population of 1993 participants by the realization rate of 58 percent (id.; Exh. DPU-1, at I-45).

Gross coincident demand savings estimates from lighting measures were based on the results of the end-use metering study (Exh. DPU-1, at I-45; Tr. 1, at 67). Net annual coincident demand savings were calculated as the product of (1) the gross demand savings estimates, (2) the persistence factor, and (3) the free-ridership factors (Exh. DPU-1, at IV-7).

For non-lighting measures, the Company estimated annual energy and demand savings based on engineering estimates (id. at I-46; Tr. 1, at 17-18).[41] The Company stated that, because the demand savings attributable to non-lighting measures were less than five percent of total program demand savings, it did not concentrate its evaluation efforts on non-lighting measures (id.; Exh. DPU-1, at I-46).[42] The Company stated that it did not adjust the engineering estimates to account for savings persistence because these measures were recently installed and it wanted to have measures in place at least two years before attempting to assess measure persistence (Tr. 1,

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41 Economizers installed on walk-in coolers accounted for approximately 92 percent of the non-lighting energy savings achieved through this program during 1993 (Exh. DPU-1, at App. I-1-19).

42 The Company stated that, as part of its 1994 M&E activities, it will be performing some metering and, possibly a billing analysis, of some non-lighting measures (Tr. 1, at 17).

at 21).

Net lifetime energy and demand savings estimates for both lighting and non-lighting measures were calculated by multiplying the annual savings estimates by measure-specific lifetimes (Exh. DPU-1, App. I-1-19).

b. Analysis and Findings

The record demonstrates that, in determining energy and demand savings estimates for lighting measures, the Company employed two distinct approaches: billing analysis and end-use metering. Consistent with Department precedent, the Department finds that both techniques are appropriate for determining savings estimates. See D.P.U. 92-217-B at 12-17 (1994); Cambridge Electric Light Company/Commonwealth Electric Company, D.P.U. 94-2/3-CC at 12-17 (1994) ("ComElectric").

The billing analysis submitted by the Company compared the energy consumption of sample groups of program participants and nonparticipants in pre- and post-installation periods, with both groups stratified according to facility type and annual energy consumption. The Department previously has found that the inclusion of a nonparticipant comparison group in a billing analysis implicitly may account for unrelated factors such as free riders, economic changes, and persistence, and thus may produce net savings estimates. D.P.U. 92-217-B at 11; ComElectric at 13. The Department also has found that stratifying the sample groups can provide a method for selecting a sample that best represents the population. D.P.U. 92-217-B at 12; ComElectric at 14. Accordingly, the Department finds that the energy savings estimates produced by the billing analysis are sufficiently unbiased and are measured to a sufficient level of precision.

The record indicates that the Company's end-use metering study essentially remained unchanged from the previous year's study, with the addition of one 1993 installation and the reweighting of the study's results to reflect the mix of measures installed during 1993. The Department previously has stated that Companies should consider the cost when determining the extent of their measurement and evaluation activities. BECo at 100-103, 110; D.P.U. 90-261, at 106, 108. The Department finds that, because of the costs associated with the metering of additional sites and because the Small C\I Program did not change significantly between 1992 and 1993, the Company has acted appropriately in limiting its metering efforts to one additional site and in reweighting the 1992 data to reflect 1993 program implementation. In addition, the Department finds that, because the energy savings estimates produced by the end-use metering were adjusted to account for free-ridership and persistence, these savings estimates are sufficiently unbiased and are measured to a sufficient level of precision.

The Department previously has directed companies to reconcile differences in savings estimates when more than one savings estimation technique is applied to a particular program. Fitchburg Gas and Electric Light Company, D.P.U. 92-181-A at 43 (1994). In the instant proceeding, the Department finds that, because the Company could not determine any significant flaws in either the billing analysis or the end-use metering study, the Company acted reasonably in using the arithmetic average of the realization rates produced by the two techniques. The Department therefore finds that the savings estimates for lighting measures installed during 1993 are sufficiently unbiased and are measured to a sufficient level of precision.

The record shows that the Company determined savings estimates for non-lighting

measures based on engineering estimates of those savings. The Department previously has found substantial bias in engineering estimates of DSM savings (see Section II, above). However, as discussed above, the Department also has stated that companies should consider the cost when determining the extent of their measurement and evaluation activities. In the instant proceeding, the Department accepts the Company's savings estimates for nonlighting measures, primarily because these savings are a relatively small portion of total program savings. However, the Department expects the Company, as part of its Second Look evaluation of savings for the 1993 Small C/I Program,[43] to increase the level of savings estimates for non-lighting measures that are based on measured data.

Based on the above analysis, the Department finds that the 1993 impact evaluation for the Small C/I Program satisfies the criteria established by the Department for the review of such evaluations. Accordingly, the Department accepts the First Look savings estimates reported by the Company for 1993.

3. Performance Engineering and Verification Service

a. Description

The Performance Engineering and Verification ("PE") Service is designed to identify cost-effective non-lighting measures that would qualify for rebates under the D2000 and EI Programs; the PE Service is offered in conjunction with these programs (Exh. DPU-1, at I-41).[44] The

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[43] The Department notes that, because the First Look savings estimates for this program exceeded the tracking estimates by more than ten percent, the Company is required to conduct a Second Look evaluation of savings (Exh. DPU-1, at I-66 through I-67).

[44] Approximately 72 percent of savings from the PE Service were achieved through the installation of custom measures. The majority of the remaining savings were achieved

program served 20 customers during 1993 and achieved annual energy and demand savings estimates of 5,602 MWH and 879 KW, respectively (id. at I-42).[45]

The Company determined gross annual energy and demand savings estimates based on metered data for the ten installation sites where such data were available (id. at I-43).[46] For those installations where metered data were not available, the method for determining savings estimates varied by end use (id.). For custom installations, a realization rate was developed based on those custom installations where metered data were available; the realization rate was applied to the engineering savings estimates for the non-metered custom installations (id.). For VSD installations, savings estimates were developed using the same methodologies that were used to determine savings estimates for VSDs installed through the D2000 and EI programs (see, Section IV.C.1.c, above). Finally, for HVAC installations, savings estimates were based on engineering estimates provided on project applications (id.).

To derive net lifetime savings estimates, the Company adjusted the gross annual savings estimates by (1) a free-ridership factor of 19 percent, developed through the 1993 PE Service process evaluation, and (2) measure-specific lifetimes (id. at App. I-1-18; App. II-5, at VI-14 through VI-23).

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through the installation of VSDs (Exh. DPU-1, at App. I-1-18).

[45] The Company reported a savings precision level of ±34, at the 90 percent confidence level, for both the energy and demand savings (Exh. DPU-1, App. I-2, at 10).

[46] The PE Service requires that metering equipment be installed at all participating sites to measure the savings over a two-year period (Exh. DPU-1, at I-41).

b. Analysis and Findings

The record shows that greater than 70 percent of the 1993 savings estimates for measures installed through the PE Service (i.e., custom measure installations) were developed using metered data and the extrapolation of that data to those installation sites for which metered data were not available. In addition, these savings estimates were adjusted to account for free riders. Consistent with precedent, the Department finds that end-use metering is an appropriate savings estimation technique for this type of program. See ComElectric at 17; D.P.U. 92-217-A at 14. In addition, the Department finds that the savings estimates produced by the end-use metering were sufficiently unbiased and were measured to a sufficient level of precision.

The record shows that savings achieved through the installation of VSDs were determined using the same savings estimation methods that were approved by the Department in Section IV.C.1.c, above. In addition, the savings estimates were adjusted to account for free riders. As such, the Department finds that the VSD savings estimates are sufficiently unbiased and are measured to a sufficient level of precision.

Finally, the record indicates that a small portion of the savings estimates (i.e, savings from HVAC installations) was based on engineering estimates of savings. The Department previously has stated that, although substantial bias may exist in engineering estimates of savings, companies should consider the cost and value of direct measurements when determining the extent of their M&E activities (see Section II, above). In the instant proceeding, the Department finds that, because these savings represent a small portion of total program savings, the use of engineering estimates is appropriate.

Based on the above analysis, the Department finds that the 1993 impact evaluation for the PE Service satisfies the criteria established by the Department for the review of such evaluations. Accordingly, the Department accepts the First Look savings estimates[47] reported by the Company for 1993. However, the Department expects that, since this program requires that metering equipment be installed at all participating sites over a two-year period, Second Look savings estimates for all 1993 installation should be based on post-installation measurements.

D. Residential Programs

1. Residential Electric Space Heat Program

a. Description

The Residential Electric Space Heat ("RESH") Program provides direct installation of comprehensive ECMs in electrically-heated homes with one to four units (Exh. DPU-1, at I-59).[48] The program is delivered in two stages. During an initial visit, a technical assessment ("TA") is performed in which hot water and water conservation measures and compact fluorescent light bulbs ("TA-only measures") are installed (id., App. III-5, at 2). Insulation, set-back thermostats and replacement windows ("TA-plus measures"), if determined to be cost effective, are installed at a later date (id.). The program served 4,551 customers during 1993 -- 2,395 participants had TA-only measures installed and 2,156 participants had TA-plus measures installed (id.,

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47 The Department notes that, because 1993 was the first full year of implementation for this program, the Company is required to conduct a Second Look evaluation of savings (Exh. DPU-1, at I-66 through I-67).

48 Measures installed include insulation, high-efficiency lighting fixtures and lamps, air sealing, water heating measures, set-back thermostats, and storm or replacement windows (Exh. DPU-1, at I-59).

App. I-1-27). The Company reported annual winter peak demand reduction of 3,413 KW and annual energy savings of 7,415 MWH for RESH Program installations made during 1993 (id.).

The impact evaluation for this program consisted primarily of a billing analysis that compared the pre- and post-installation energy consumption of 1,564 customers who participated in the program during 1992 (the "participant group")[49] with the pre- and post-installation energy consumption of 116 customers selected from the list of customers waiting to participate in the program (the "comparison group") (id., App. III-5 at 8-9).[50] The participant group was stratified into two groups: (1) a sample of 923 customers who had TA-only measures installed; and (2) 641 customers who had TA-plus measures installed (id.). The billing analysis produced annual energy savings estimates of 1,079 KWH per participant for TA-only participants and 2,390 KWH per participant for TA-plus participants (id., App. III-5 at 11).[51]

Gross annual energy savings estimates were calculated by multiplying the per participant savings estimates produced by the billing analysis by the total number of customers who participated in the program during 1993 (id. at I-61). Gross non-coincident demand savings estimates were calculated by multiplying the gross annual energy savings estimates by a demand-to-energy ratio that reflects the relationship between the contribution to peak demand by

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49 The Company stated that the participant group consisted of all 1992 program participants for whom reliable energy consumption data existed (Exh. DPU-1, App. III-5, at 4, 8-9).

50 The pre-installation period was defined as January 1, 1991 through January 31, 1992; the post-installation period was defined as December 1, 1992 through December 31, 1993 (Exh. DPU-1, App. III-5, at 6).

51 The Company stated that the precision levels of the energy savings estimates were ±55 percent for TA-only savings and ±25 percent for TA-plus savings, at the 90 percent confidence level (Exh. DPU-1, App. I-1, at 12).

residential electric space heat customers and the total energy consumed for heating by these customers (id.).[52] Gross coincident demand savings estimates were calculated by multiplying the non-coincident demand savings estimates by coincident demand adjustment factors that were developed through the 1992 process evaluation for this program (RR-DPU-16).[53]

Net annual energy and coincident demand savings estimates were calculated by multiplying the gross annual savings estimates by free-ridership factors that were developed through the 1992 process evaluation for this program (Exh. DPU-1, at I-61).[54] Finally, net lifetime savings estimates were calculated by multiplying the annual savings estimates by weighted average measure lives of twelve years for TA-only measures and 20 years for TA-plus measures (id.).

b. Analysis and Findings

The record shows that the 1993 savings estimates for the RESH Program were determined from a billing analysis, for the energy savings estimates, and from a demand-to-energy ratio, for the demand savings estimates. The Department notes that these savings estimation techniques are, in most respects, identical to the techniques used by the Company in its 1992

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[52] The Company stated that the demand-to-energy ratio of 0.00047 was developed from its load research data for residential space heat customers (Exh. DPU-1, at I-61).

[53] The coincident demand adjustment factors were 0.969 for winter months and 0.396 for summer months (RR-DPU-16).

[54] The Company stated that, because the comparison group was selected from the list of customers waiting to participate in the program during 1994, the billing analysis did not account for free riders (Exh. DPU-1, App. III-5, at 5). The free-ridership adjustment factors were 95.9 percent for TA-only measures and 95.8 percent for TA-plus measures (id., App. III-5, at 10).

evaluation of this program, and approved by the Department in D.P.U. 92-217-B. Id. at 65-69. The Department also notes that design of the RESH Program did not change significantly between 1992 and 1993. The one distinction between the 1992 and 1993 impact evaluations is the way in which the results of the billing analyses were applied to the total population of program participants. The 1992 evaluation multiplied the realization rate produced by the billing analysis by the engineering estimates developed for the population of 1992 participants, whereas the 1993 evaluation multiplied the per-participant savings estimates produced by the billing analysis by the number of 1993 participants. The Department finds that either method is acceptable. As such, the Department finds that the savings estimation techniques described above are appropriate for this program.

With respect to the resultant savings estimates, the Department notes that the participant group used in the billing analysis consisted of all 1992 program participants for whom reliable energy consumption data existed and that the comparison group was selected from the list of customers waiting to participate in the program. In addition, the Company adjusted the results of the billing analysis to account for free riders. As such, the Department finds that the energy savings estimates produced by the billing analysis are sufficiently unbiased and are measured to a sufficient level of precision. The Department also finds that, because the demand savings estimates were calculated based on the results of the billing analysis and on load research data developed for residential space heat customers, the demand savings estimates are sufficiently unbiased and are measured to a sufficient level of precision.

Based on the above analysis, the Department finds that the 1993 impact evaluation for the

RESH Program satisfies the criteria established by the Department for the review of such evaluations. Accordingly, the Department accepts the savings estimates reported by the Company for 1993.

2. Residential Lighting Program

a. Description

The Residential Lighting Program provides customers the opportunity to purchase compact fluorescent lamps at "substantial discounts," either through a mail order system or through rebate coupons for qualifying models purchased in retail stores (Exh. DPU-1, at I-61).[55] The program served 50,839 customers in 1993, selling 170,909 energy-efficient lamps. The Company reported annual winter peak demand savings of 2,390 KW and annual energy savings of 8,451 MWH resulting from 1993 installations (id. at I-61; App. I-1-26).

The impact evaluation for this program consisted primarily of three activities: (1) on-site inspections conducted at 106 homes covering 449 lamp purchases; (2) time-of-use meters (referred to as "lighting loggers") installed on 171 lamps in 56 homes for two weeks during February 1994 ("short-term metering study"); and (3) lighting loggers installed on 41 lamps in 25 homes for periods of five months to one year during 1993 ("long-term metering study") (id. at I-63; App. II-3, App. A-2-1).

Annual gross coincident demand savings estimates were determined in the following manner. First, the Company developed displaced wattage values for each lamp type based on its

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[55] MECo also participated in a joint utility promotion, during September and October, 1993, that provided instant in-store rebates to customers at participating retail stores (Exh. DPU-1, at I-61).

recommendation that incandescent light bulbs be replaced with "equivalent lumen output flourescents" (id. at I-63). Second, for each lamp type, the Company multiplied the displaced wattage value by the number of those lamps purchased through the program (id.). Third, based on the results of its on-site inspections, the Company applied an in-service rate (i.e., the percentage of lamps purchased that were installed and in use at the time of the inspection) to the savings estimates (Exh. DPU-1, App. II-3, at 6-2, 3).[56] Finally, the demand savings estimates were adjusted by coincident demand factors that were developed through the Company's long-term metering activities (RR-DPU-42).[57]

Annual gross energy savings estimates were determined by multiplying the annual non-coincident demand savings estimates by average annual hours of operation, as developed through the Company's long-term metering activities (id.).[58]

Net annual energy and coincident demand savings estimates were calculated by adjusting the gross annual savings estimates by a free-ridership factor of 0.4 percent, as determined from a telephone survey of 352 participants (Exh. DPU-1, App. II-3, at 6-9).[59] Finally, net lifetime

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56 In those instances where lamps had not been installed, but a participant indicated an intent to install the lamps within a year, the lamps were considered to be in service. In-service rates were developed separately for the mail order (72.6 percent) and retail (85.0 percent) components of the program (Exh. DPU-1, App. II-3, at 6-2, 3).

57 The coincident demand factors were 0.049 for summer months and 0.340 for winter months (RR-DPU-42).

58 Average annual hours of operation were estimated to be 1,202 hours (RR-DPU-42).

59 The Company defined free riders as those participants who indicated that, in the absence of this program, they would have been willing to pay the average price for the number of lamps that they planned to purchase (Exh. DPU-1, App. II-3, at 6-9).

savings estimates were calculated by multiplying the annual savings estimates for each lamp type by the average measure live for that lamp type (id., App. I-1-26).

b. Analysis and Findings

The record shows that the 1993 energy and demand savings estimates for the Residential Lighting Program were determined from a combination of telephone surveys, on-site inspections, and time-of-use metering. The Department notes that these savings estimation techniques are similar to the techniques used by the Company in its 1992 evaluation of this program, and approved by the Department in D.P.U. 92-217-B. Id. at 71-72. The Department also notes that design of the Residential Lighting Program did not change significantly between 1992 and 1993. For these reasons, the Department finds that the 1993 impact evaluation for the Residential Lighting Program is appropriate. In addition, the Department finds that, because the savings estimates were adjusted to account for savings persistence and free-ridership, the estimates are sufficiently unbiased and measured to a sufficient level of precision.

Based on the above analysis, the Department finds that the 1993 impact evaluation for the Residential Lighting Program satisfies the criteria established by the Department for the review of such evaluations. Accordingly, the Department accepts the savings estimates reported by the Company for 1993.

3. Multi-Family Program

a. Description

The Multi-Family Program provides direct installation of ECMs to electrically-heated multifamily facilities with five or more units (Exh. DPU-1, at I-55). Measures installed include

insulation, high-efficiency lighting fixtures and lamps, air sealing, water heating measures, set-back thermostats, and storm or replacement windows (id.). The program served 4,196 customers in 74 facilities during 1993 (id.). The Company reported annual winter peak demand reduction of 2,922 KW and annual energy savings of 6,217 MWH (id.).

The impact evaluation for this program consisted primarily of a billing analysis that compared the pre- and post-installation energy consumption of 586 customers in 13 facilities who participated in the program during 1992 (the "participant group")[60] with the pre- and post-installation energy consumption of 611 customers in 15 facilities selected from the list of customers waiting to participate in the program (the "comparison group") (id. at I-57).[61] The billing analysis produced annual energy savings estimates of 1,249 KWH per participant (id., App. III-4, at 10).[62]

Gross annual energy savings estimates were calculated by multiplying the per participant savings estimates produced by the billing analysis by the total number of customers who participated in the program during 1993 (id.). Gross coincident demand savings estimates were calculated by multiplying the gross annual energy savings by a demand-to-energy ratio that reflects the relationship between the contribution to peak demand by residential electric space heat

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60 The Company stated that the participant group consisted of all 1992 program participants for whom reliable energy consumption data existed (Exh. DPU-1, App. III-4, at 4, 7).

61 The pre-installation period was defined as January 1, 1991 through January 31, 1992; the post-installation period was defined as December 1, 1992 through December 31, 1993 (Exh. DPU-1, App. III-4, at 6).

62 The Company stated that the precision level of the energy savings estimates was ±53 percent, at the 90 percent confidence level (Exh. DPU-1, App. I-1, at 12).

customers and the total energy consumed for heating by these customers (RR-DPU-34).[63]

Net annual energy and coincident demand savings estimates were calculated by adjusting the gross annual savings estimates by a free-ridership factor that was developed through the 1993 process evaluation for this program (Exh. DPU-1, at I-57).[64] Finally, net lifetime savings estimates were calculated by multiplying the annual savings estimates by an average measure life of 17 years (id.).

b. Analysis and Findings

The record shows that the 1993 savings estimates for the Multi-Family Program were determined from a billing analysis, for the energy savings estimates, and from a demand-to-energy ratio, for the demand savings estimates. The Department previously has found that a billing analysis of program participants that employs a comparison group can provide accurate estimates of energy savings at modest expense. D.P.U.90-261, at 103. In addition, the Department has found that the use of a demand-to-energy ratio (also referred to as "load-shape data"), in combination with a billing analysis, is potentially less expensive than end-use metering, is largely based on actual data, and, thus, provides an adequate basis for determining demand savings estimates. Id. at 108-109; BECo at 108. In the instant proceeding, the Department finds that these savings estimation techniques are appropriate for this program.

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63 The Company stated that the demand-to-energy ratio of 0.00047 was developed from its load research data for residential space heat customers (Exh. DPU-1, at I-57).

64 The Company stated that, because the comparison group was selected from the list of customers waiting to participate in the program, the billing analysis did not account for free riders (Exh. DPU-1, App. III-4, at 9). The free-ridership adjustment factor was 4.2 percent (id.).

With respect to the resultant savings estimates, the Department notes that the participant group used in the billing analysis consisted of all 1992 program participants for whom reliable energy consumption data existed and that the comparison group was selected from the list of customers waiting to participate in the program. In addition, the Company adjusted the results of the billing analysis to account for free riders. As such, the Department finds that the energy savings estimates produced by the billing analysis are sufficiently unbiased and are measured to a sufficient level of precision. The Department also finds that, because the demand savings estimates were calculated based on the results of the billing analysis, the demand savings estimates are sufficiently unbiased and are measured to a sufficient level of precision.

Based on the above analysis, the Department finds that the 1993 impact evaluation for the Multi-Family Program satisfies the criteria established by the Department for the review of such evaluations. Accordingly, the Department accepts the First Look savings estimates reported by the Company for 1993.[65]

4. Home Energy Management Program

a. Description

The Home Energy Management ("HEM") Program, initiated in 1990, is designed to reduce the Company's peak demand primarily by controlling the operation of residential electric water heaters for six, 13, or 16 hours during peak periods (Exh. DPU-1, at IV-19).[66] The

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[65] The Department notes that, because the First Look savings estimates for this program exceeded the tracking estimates by more than ten percent, the Company is required to conduct a Second Look evaluation of savings (Exh. DPU-1, at I-66 through I-67).

[66] In addition to electric water heaters, the program included 12 pool pumps and one air (continued...)

Company stated that it controls electric water heaters using radio signals or time clocks that automatically turn off the water heaters at times of system peak demand (id. at I-53, I-54). The Company served a total of 5,131 customers in 1993, with participating customers receiving fixed monthly credits on their bills (id. at I-53). The Company reported annual demand and energy savings of 2,168 KW and 1,100 MWH, respectively, resulting from the 1993 implementation of this program (id. at I-54; Exh. DPU-56).

The Company determined demand savings estimates based on special meters installed on water heaters at 104 participants' homes (Exh. DPU-1, at I-54).[67] Water heaters at the sample of 104 homes were controlled on one day, then not controlled the next, over a series of days (id.). The analysis consisted of measuring the difference in energy consumption by those water heaters on controlled and uncontrolled days (id. at I-54, I-55). The difference in energy consumption between controlled and uncontrolled days was divided by the number of controlled hours to calculate demand savings estimates (id., App. IV-6, at 11).[68]

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[66](...continued)
conditioner in 1993 (Exh. DPU-1, at I-53).

[67] The Company stated that it stratified the participant sample (i.e., those receiving the measurement meters) into three groups according to household type and size, so that the sample would be representative of the total population of program participants (Exh. DPU-1, at I-54).

[68] The Company reported per-customer winter peak demand savings estimates of 0.549 KW for the 6-hour group, and 0.362 KW for both the 13-hour and the 16-hour groups (Exh. DPU-1, App. IV-6, at 1). The Company reported ±16 percent precision for the demand savings estimates at the 90 percent confidence level (id., App. I-2, at 3).

b. Analysis and Findings

The record indicates that the Company determined demand savings for the HEM Program using end-use meters. The record also indicates that the Company stratified the participant sample in an attempt to ensure that the participants selected for end-use metering were representative of the entire group of program participants. The Department notes that the method used is identical to that approved by the Department in its review of the 1992 HEM Program, and that the average KW savings estimates per customer are quite close to those reported for 1992. See D.P.U. 92-217-B at 73. Therefore, the Department finds that the savings estimates are sufficiently unbiased and that the Company's method achieves a reasonable level of precision. Accordingly, the Department accepts the Company's 1993 demand and energy savings estimates from the HEM Program.

5. Other Residential Programs

The record shows that the combined 1993 lifetime savings for the Appliance Recycling, Complementary RFP, Energy Crafted Home, Energy Fitness, and Water Heater Rebate Programs represent less then two percent of total lifetime savings produced through the implementation of the Company's 1993 programs (Exh. DPU-1, at App. I-1-1). For this reason, the Department addresses these programs in a combined manner. Based on its review of the 1993 impact evaluations associated with these programs, the Department finds that the evaluations are appropriate and that the savings estimates included in the evaluations are sufficiently unbiased and are measured to a sufficient level of precision. Accordingly, the Department accepts the 1993 savings estimates for these programs as submitted by the Company.

E. Precision of the Company's Estimates

The Company estimated the precision of the estimated savings from its combined programs, all at the 90 percent confidence level (Exh. DPU-1, App. I-2, at 1). Precision was not estimated for a few programs or for a few ECM types within programs, specifically those for which savings were not measured (id.).[69] The Company estimated the precision of total energy savings to be ±16 percent (19 percent for programs targeting the C/I sector and 21 percent for programs targeting the residential sector)[70] (id.). Similarly, the Company estimated the precision of total capacity savings to be ±10 percent (12 percent for C/I programs and 18 percent for residential programs) (id.).

The Department notes that the Company's estimated precision has improved from last year's filing, due in large part to use of measured savings results for programs where none were available last time (id. at 2-3). See also D.P.U. 92-217-B at 83. The Department commends the Company's improvement and accepts the Company's estimates of precision.

V. PROPOSED CC RATES

A. Introduction

As stated in Section I, above, the Company submitted its 1995 CC filing on December 7, 1994. The Company proposed that the 1995 CC rates remain unchanged from the

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69 The Company was able to estimate precision based on measurements for all but about 4 percent of its estimated savings (Exh. DPU-1, App. I-2, at 2-3). For these, the Company assumed that the relative precision was equal to the estimated savings (id. at 1).

70 Due to the statistical properties of variances, which underlie precision, the precision of a sum is generally better than the precisions of the parts of a sum.

1994 CC rates, stating that this is consistent with the goal of CC rate stabilization set forth in the Offer of Settlement approved by the Department in Massachusetts Electric Company, D.P.U. 94-112 (1994), the Company's regional Integrated Resource Planning proceeding that addressed, inter alia, DSM implementation during the years 1995 and 1996 (Exh. DPU-89, at 1-2).[71]

The Company's CC filing shows that, under its proposed approach, the Company projects to over-collect $11.9 million through its CC rates during 1995 (Exh. DPU-89, Att. 1). The over-collection was determined through a comparison of the revenue that would be collected through its proposed CC rates and the Company's projected 1995 DSM revenue requirement. The Company's 1995 DSM revenue requirement consists of three components: (1) projected 1995 DSM expenditures of $60.6 million; (2) a DSM incentive, based on activities during the program year 1993, of $3.3 million;[72] and (3) a reconciling adjustment of $17.6 million, reflecting the refund to ratepayers of a projected over-collection of DSM expenditures through the end of 1994 (id.). Under the Company's proposal, of the projected 1994 over-collection of $17.6 million, only $5.6 million would be refunded to ratepayers during 1995; the remaining $11.9 million would be "over-collected" during 1995 and would be refunded, plus interest, to ratepayers

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[71] The D.P.U. 94-112 Offer of Settlement was approved by the Department on October 31, 1994.

[72] The incentive listed here represents the before-tax amount that will provide the Company with an after-tax incentive of $1.98 million, as discussed in Section I, above (Exh. 89, Att. 1).

during 1996 (id.; Exh. 89, at 1-2).[73]

B. Analysis and Findings

In this section, the Department addresses two issues: (1) whether the projected 1995 DSM revenue requirement components identified by the Company are acceptable; and (2) whether the Company's proposal to keep the 1995 CC rates unchanged from the 1994 CC rates is appropriate and in the best interest of ratepayers. With respect to the projected DSM revenue components, the Department finds that the projected 1995 DSM expenditures are consistent with the implementation levels approved by the Department in D.P.U. 94-112. In addition, the Department finds that the 1993 DSM incentive is consistent with the 1993 savings estimates approved by the Department in Section IV of this Order. Therefore, the Department accepts the 1995 DSM revenue requirement components identified by the Company.

With respect to the Company's proposal to maintain the 1995 CC rates at 1994 levels, the Department notes that, in principle, the proposal is consistent with the Department's goal of rate continuity. However, the Department must weigh the benefits of rate continuity against the projected 1995 over-collection of approximately $11.9 million that would result from the implementation of the Company's proposed CC rates. The Department recognizes that there may be instances when, for the purposes of maintaining rate continuity, it is appropriate to implement CC rates that result in an over- or under-collection at the end of a particular year. For example, if a company projects that a particular rate class' participation in its DSM programs will fluctuate

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[73] The Department notes that, although the Company's CC filing contains information regarding its projected 1996 DSM activities and CC rates, the Company is requesting Department action only for the CC rates to be effective during 1995 (Exh. 89, at 1-2, Att. 1).

significantly between two consecutive years, it may be appropriate to implement a two-year CC rate for that rate class that would collect the required revenue over the two-year period, but that would result in an over- or under-collection during the first year. Such an approach would avoid large changes in the CC rate that reflect the fluctuations in program participation.

The record in this proceeding, however, shows that the projected 1995 over-collection that would occur under the Company's proposal would not result from fluctuations in program participation during 1995 and 1996. Instead, as described above, the 1995 over-collection would result from a carry-over of the over-collection projected for the end of 1994. The Department finds that ratepayers are best served by setting CC rates so that the entire 1994 over-collection amount is returned to ratepayers during 1995. Accordingly, the Department rejects the Company's proposal to maintain the 1995 CC rates at 1994 levels. Instead, the Department finds that the Company should implement 1995 CC rates that are projected to produce no over-collection during 1995 (such CC rates were presented by the Company in Attachment 2 of its CC filing). Therefore, the Department approves the 1995 CC rates identified in Table 4, below. The 1995 CC rates shall be implemented effective January 1, 1995.

TABLE 4

Rate Classes	1994 CC Rates	1995 CC Rates
R1/R4	$0.00371	$0.00307
G1	$0.00629	$0.00703
G2	$0.00388	$0.00301
G3	$0.00298	$0.00175
G4	$0.00386	$0.00284

VI. ORDER

Accordingly, after due notice, hearing, and consideration, it is hereby

ORDERED: That the lifetime savings estimates from 1993 demand-side management installations for which the Massachusetts Electric Company has requested approval are approved, as set forth above; and it is

FURTHER ORDERED: That the 1995 conservation charge rates proposed by Massachusetts Electric Company are hereby rejected; and it is

FURTHER ORDERED: That Massachusetts Electric Company shall implement the 1995 conservation charge rates as set forth in Table 4 on page 52 of this Order; and it is

FURTHER ORDERED: That Massachusetts Electric Company shall comply with all other directives contained herein.

By Order of the Department,

_____
Kenneth Gordon, Chairman

_____
Mary Clark Webster, Commissioner